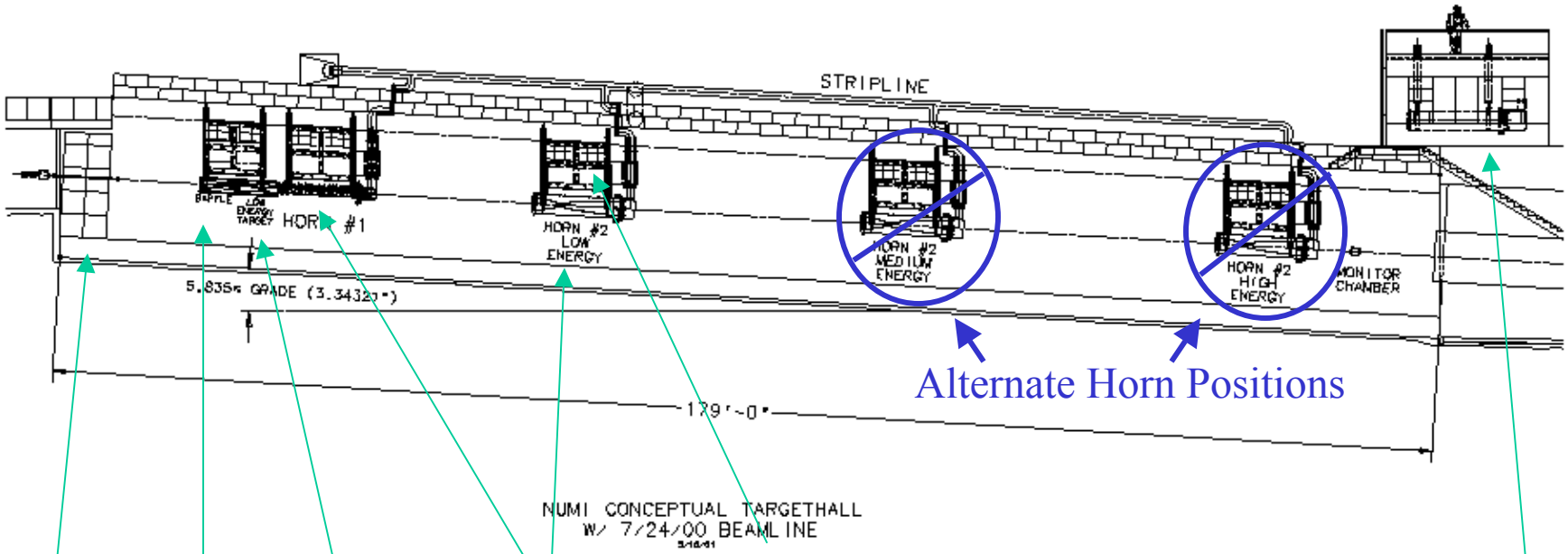
WBS 1.1.2 Neutrino Beam Devices Target Hall Instrumentation Review

Agenda:

- Overview - J. Hylen (15+5) min
- Electronics channels (readout into ACNET and Beam Permit, comprehensive list of channels, details of motor controls, LVDT's, thermocouples) - R. Talaga (30+15) min
- Cross Hair System - D. Ayres (15+10) min
- Recirculating Air System Controls - A. Stefanik (15+10) min

(Times: minutes of talk + minutes allowance for discussion)

What is WBS 1.1.2 Scope ?
Neutrino Beam Production Devices and Target Pile



Alternate Horn Positions

Beamline Component Positioning Modules

Two Types of Magnetic Focusing Horns

Pion Production Target (plus readout of target, vacuum pump)

Baffle to protect horn from beam accidents

Target Hall Radiation Shielding

Hot (Radioactive) Component Workcell and Hot Handling Procedures/Tooling

Shield Pile Recirculating Air Cooling System

Lifting fixtures, transportation carts, magnetic field probes, prototyping, test stand, install

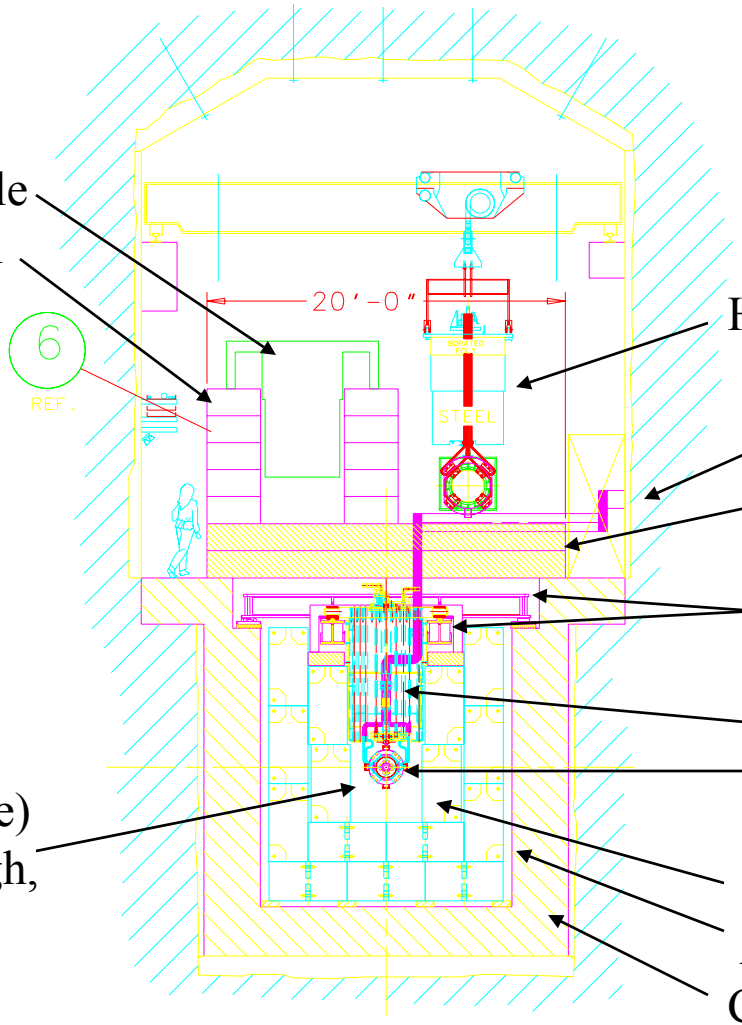
NuMI Target Hall

beam's eye view

Temporary Stackup of removed shielding

Steel from module middle

Concrete from over horn



Horn+Module in transit

Stripline

Concrete Cover

"Carriage" - Module Support Beams

Horn Shielding Module

Horn

Beam passageway (chase) is 1.2 m wide x 1.3 high, forced-air-cooled

Steel Shielding

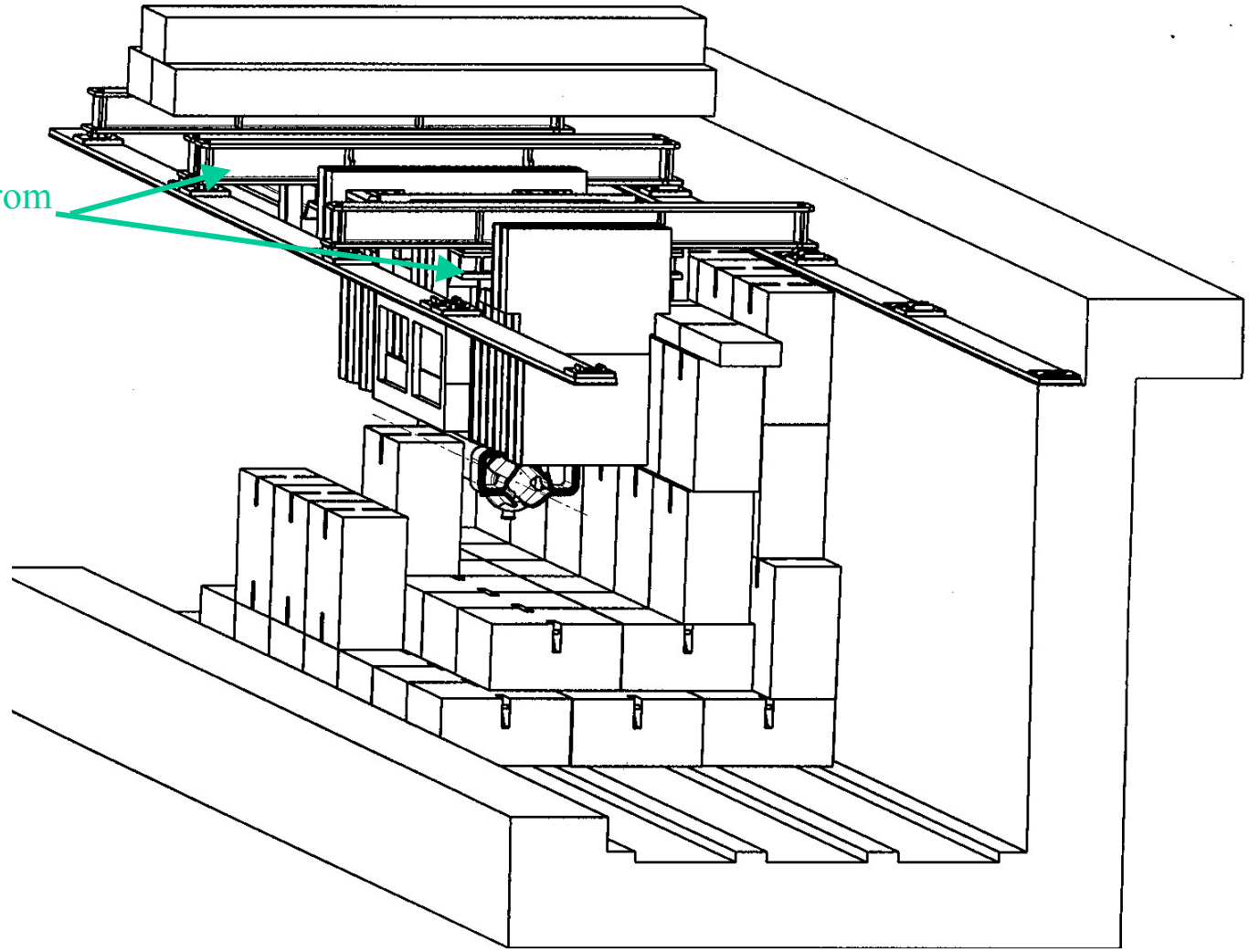
Air Cooling Passage

Concrete Shielding

Target Pile Shielding and Carriages

Carriages:

Cross-beams that modules hang from



Target Hall Instrumentation
Scope of This Review

This review:

- Connection to ACNET (MADC, PLC) (Rich Talaga)
- Connection to beam permit system (Rich Talaga)
- Alarms and limits (Rich Talaga)
- Module motion control (Rich Talaga)
- Cross hairs alignment system (Dave Ayres)
- Recirculating-forced-air cooling system instrumentation (Andy Stefanik)

Devices not in review, but channel count / readout path is:

- Field monitor Bdot (have tested prototype)
- Target – Budal (tested in target test), vacuum/pressure, horn-collision sensor
- Baffle – Thermocouples (reviewed last August)
- Copy of horn currents
- Check of beam-to-horn-pulse timing (device not designed yet)

Not in this review:

- RAW (target & horn cooling water) is WBS 117
- Horn Power Supply is WBS 113
- Hot Handling – camera system, hot cell controls (WBS 112 but no connection to outside systems)
- Transfer from ACNET to MINOS data stream - Brett Viren (MINOS DCS, WBS 2.3)

General Level of Design

Channel count and requirements on channels (mostly) set
(number, dynamic range, accuracy, alarm limits, beam permit usage)

Readout path (MADC, IRM, PLC) identified

Sensors identified (thermocouples, beam loss monitor chamber, pressure sensors, …)

Some signal conditioning hardware is not yet designed:
- Integration, sample and hold on the beam pulse device signals which go to MADC
- Relative timing signal between beam (Budal and BLM) and horn (current and field)
- Signal conditioning for target/horn collision (short) sensor

Types of issues we would like reviewers to address

Are we integrating into ACNET in a reasonably optimized manner?

All signals (except internal PLC control of air system) will show up in ACNET as simple parameter pages. Is this sufficient for operations?

Does the set of instrumentation for the air system look reasonable?
(e.g. we check that air is flowing by differential pressure rather than a flow sensor)

Other parameters that need specification before designing remaining hardware?

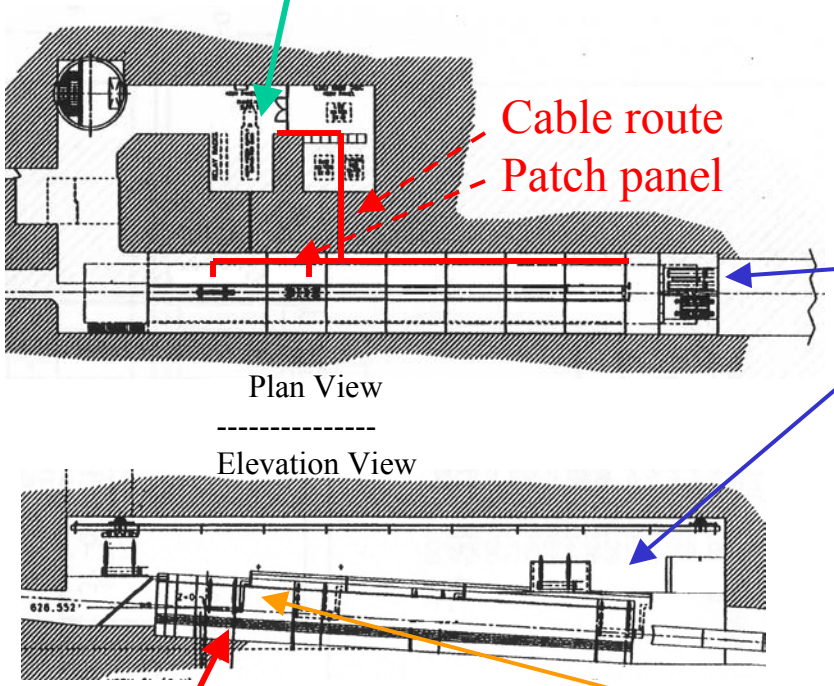
Review also brings management up to speed on current status.

Now on to a picture show to give more of a feeling what we are working with…

and some status of systems not covered by other speakers.

Radiation Levels

Power Supply Room: ~ 1 - 10 Rad/yr (MADC, differential pressure sensor, …)

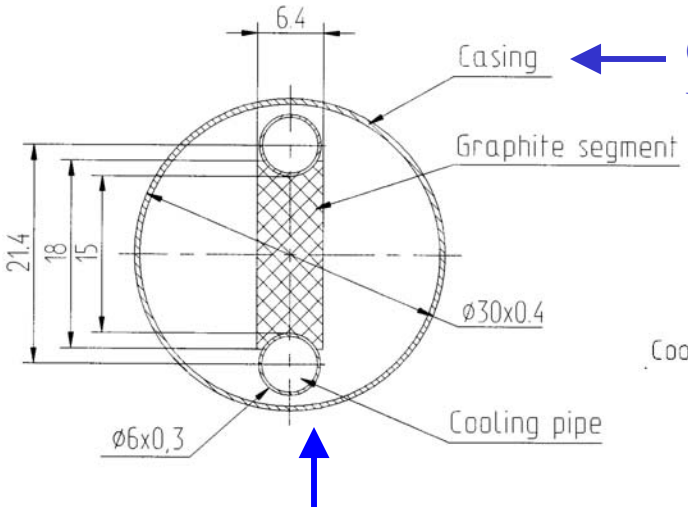


Target Hall above concrete covers:
~ 10^2 – 10^4 Rad/yr
(hot cell system, air recirculation system, humidity sensors)

Top of module, under concrete cover:
~ 10^4 – 10^5 Rad/yr
(motors, LVDTs, limit switches)

Chase, around horns: ~ 10^{10} - 10^{11} Rad/yr (thermocouples, bdot coils, BLM ionization chamber)

Target



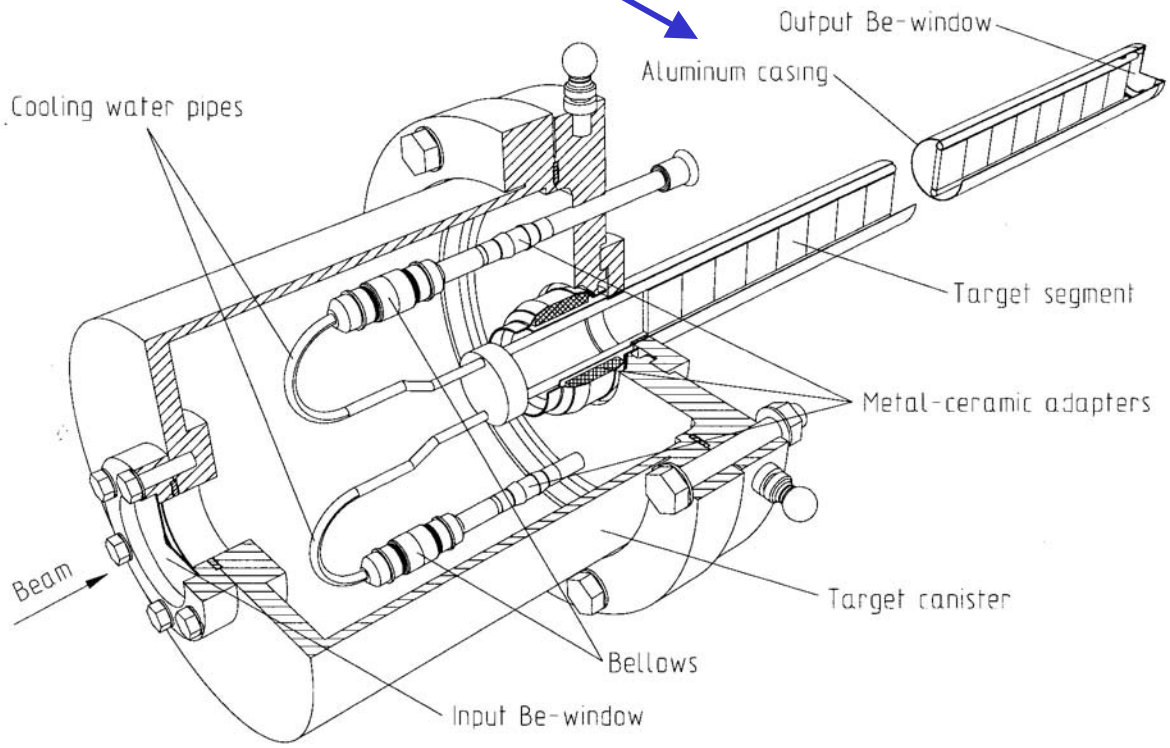
Casing of target fin electrically insulated from base. Wire strung from case to top of module. When moving, can sense if case touches horn by short to "ground".

Narrow – location checked by scanning beam across edge.

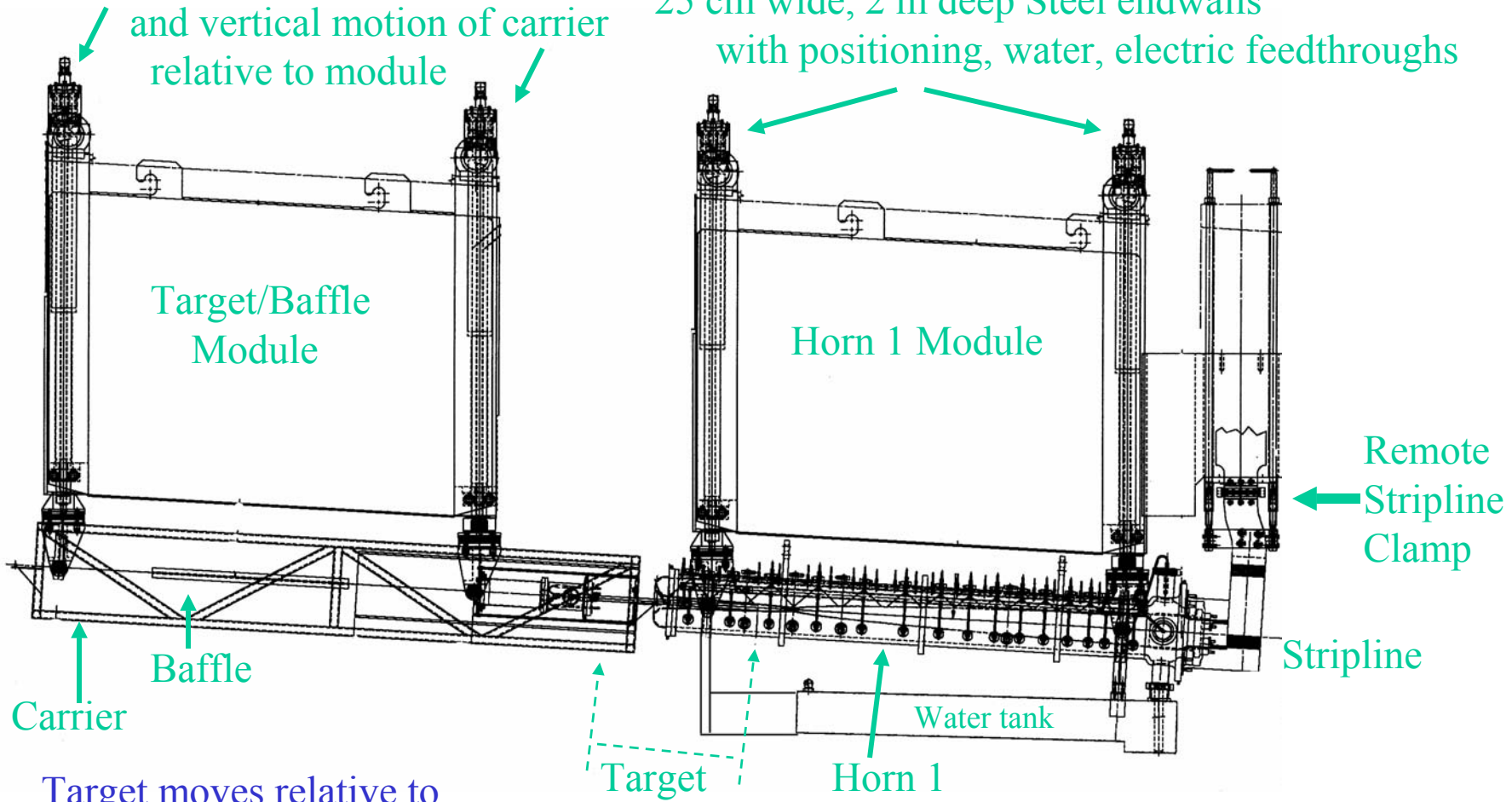
Sense by:

(i) charge (delta-rays) knocked out (wire connected to target) (called Budal)

(ii) scattered beam into cross hairs ionization chamber (BLM)



Target and Horn Module Instrumentation: motor drives and thermocouples

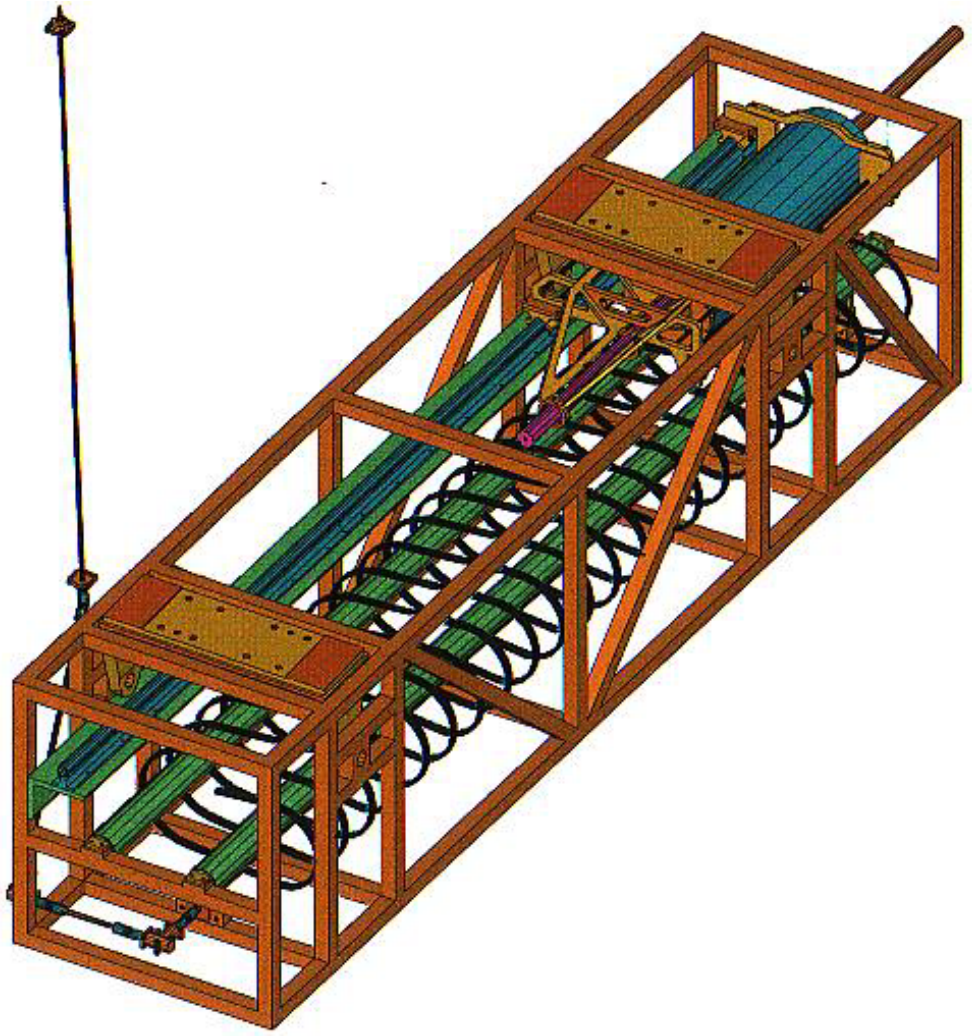


Target moves relative to carrier for insertion into horn for L.E. beam

Target/Baffle Carrier: motor drive and thermocouple

Moves Target by 2.5 m on beam axis along with water, vac., elec. lines. (extended travel aids in commissioning and monitoring)

Drive and position sensing is done behind shielding at top of module, only thermocouples are in high radiation environment



Horn
(pion focusing device)

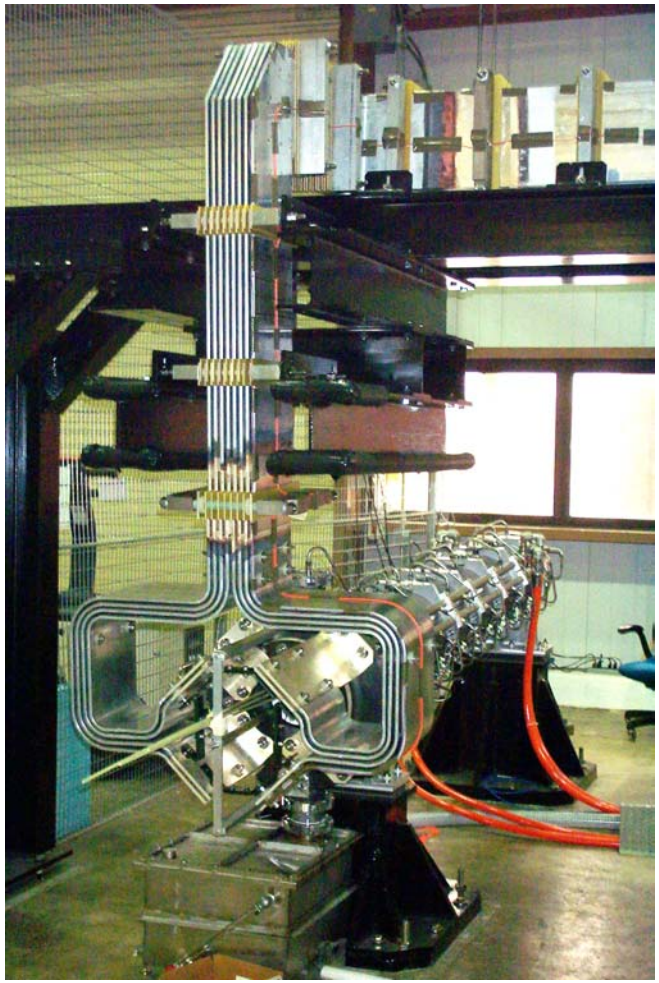
I=200 kA, 2 ms pulse
Max. field 3 Tesla

Instrumentation:

Six thermocouples on outer conductor – difference in temperature top and bottom could cause warp of horn shape

Three bdot coils to monitor magnetic field (described later)

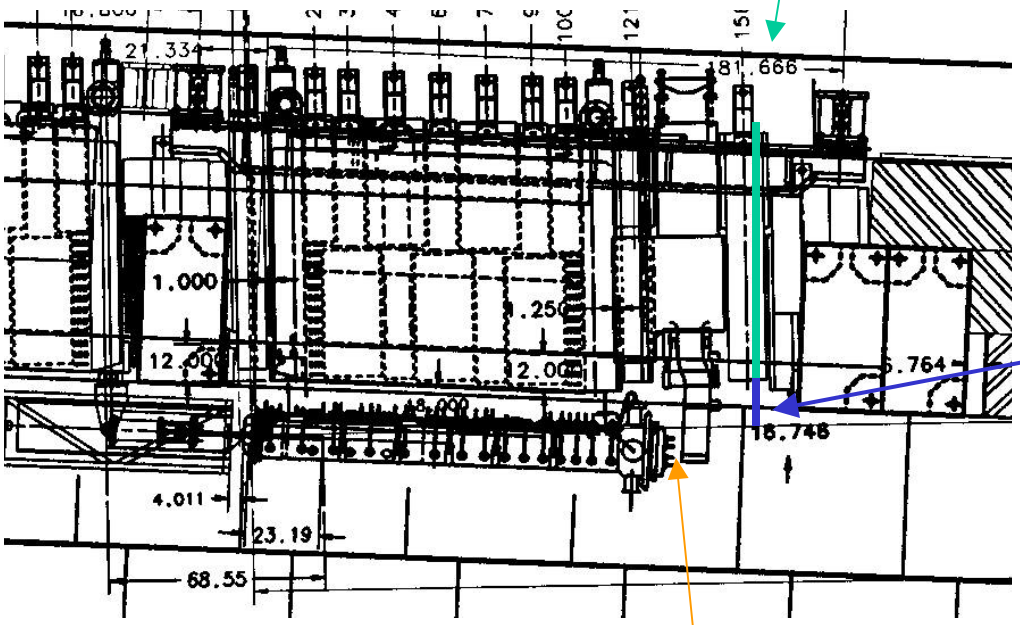
Cross hair system (described later)



Prototype horn 1 in test stand

Cross Hair Horn Alignment System

Hole in shield to insert beam loss monitor



Function: Check position of horn w.r.t. beam by beam scan (target-out)

Scan: (1) horn 1 neck
(2) horn 1 downstream
(3) horn 2 upstream
(4) horn 2 downstream

Beam loss monitor ion chamber

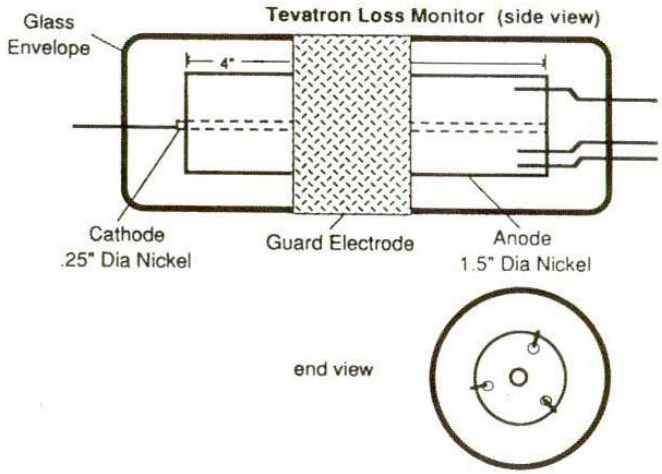
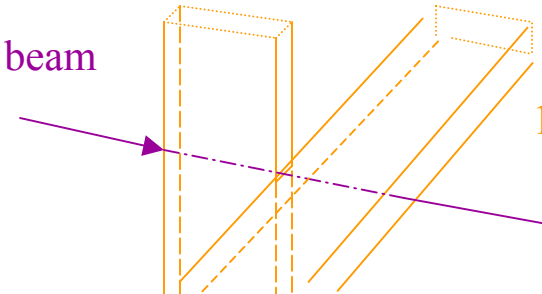


Figure 9. Schematic of Tevatron loss monitor. The monitor is filled with argon gas at 725 mm of Hg. The guard electrode reduces the leakage current



12 mm x 1 mm Aluminum cross hairs mounted on horn

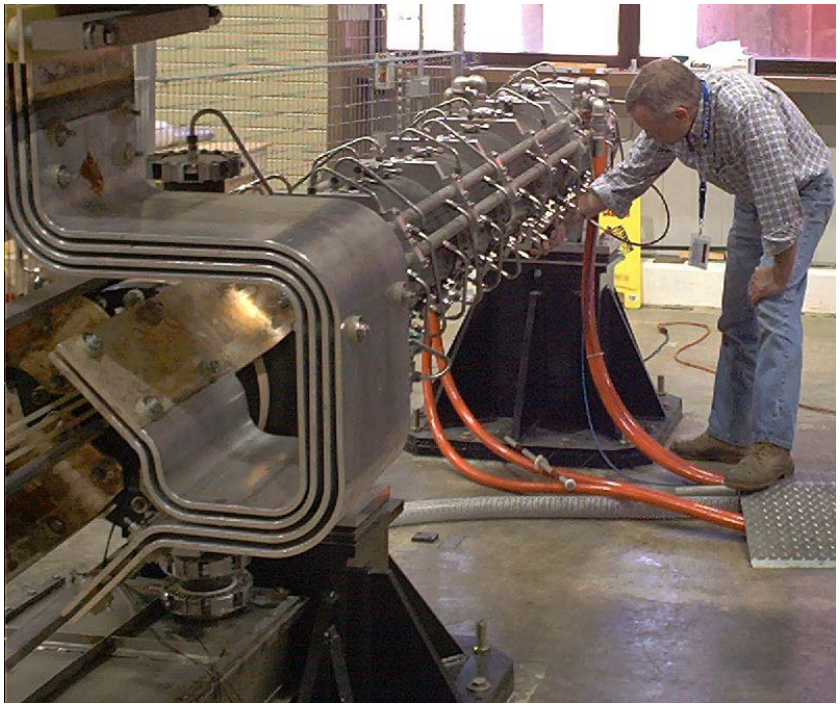
Status
Bdot Horn Magnetic Field Monitor

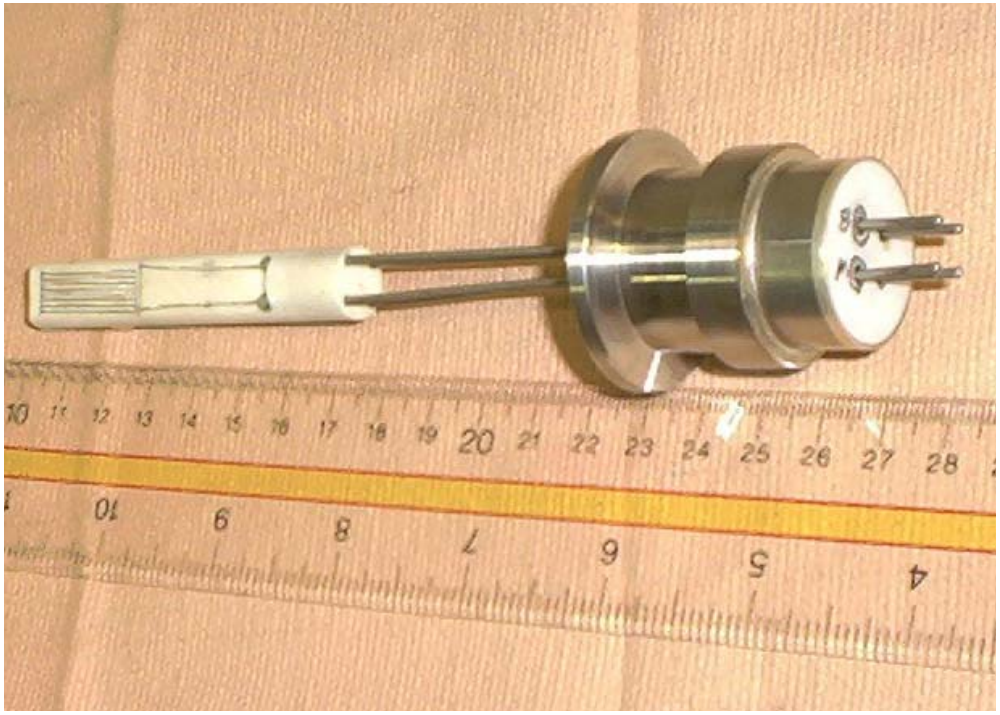
3 bdot units per horn to monitor magnetic field each pulse

Tested prototype: 8 turns of 0.01 inch diameter 304 stainless steel wire
wrapped on MACOR form, 1.010 x 0.363 sq inch per turn
mounted to Aluminum Oxide ceramic feedthrough

In process of replacing MACOR with zirconia which is more radiation-hard
(involves redesign of form for manufacturability, can't drill small holes)

Bob Wagner has demonstrated significant thermo-electric effects at solder joints



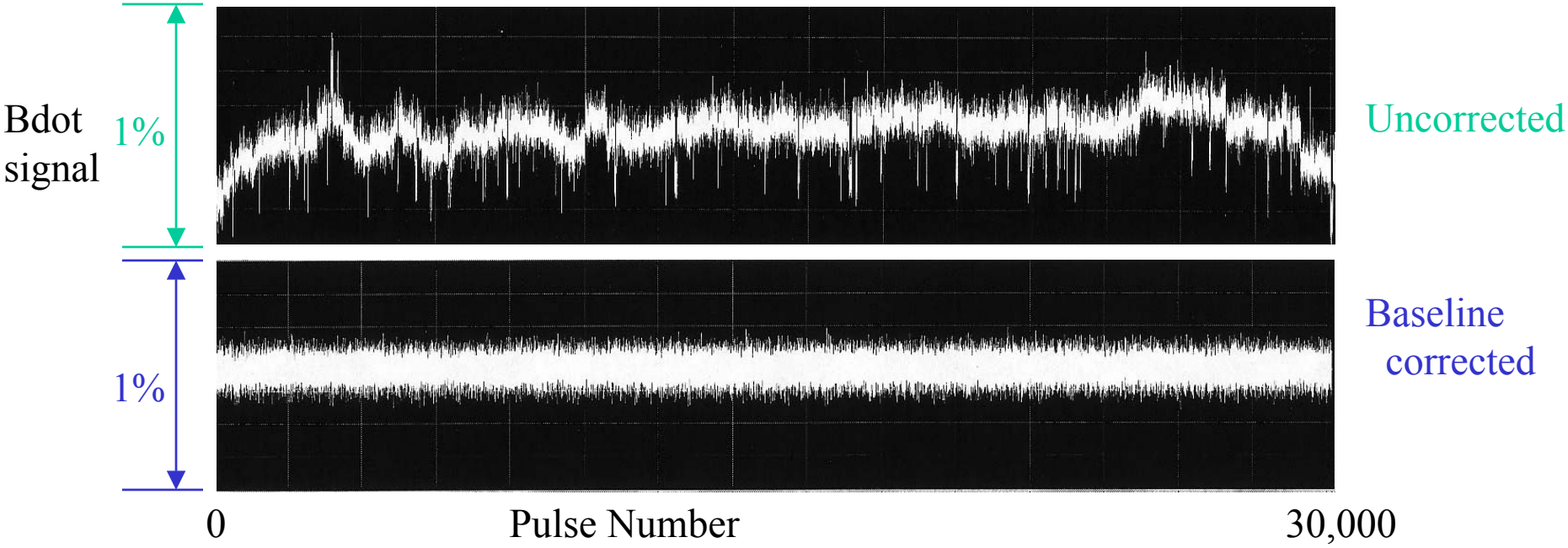


Test at MI-8 of Bdot coil magnetic field monitoring pickup

Frank Nezrick demonstrated that sampling the off-pulse baseline and subtracting it from the signal gets rid of the thermally induced bdot instability

Goal of 0.4% stability has been achieved this way

Integrator built, but module to do subtraction in production DAQ has not been designed

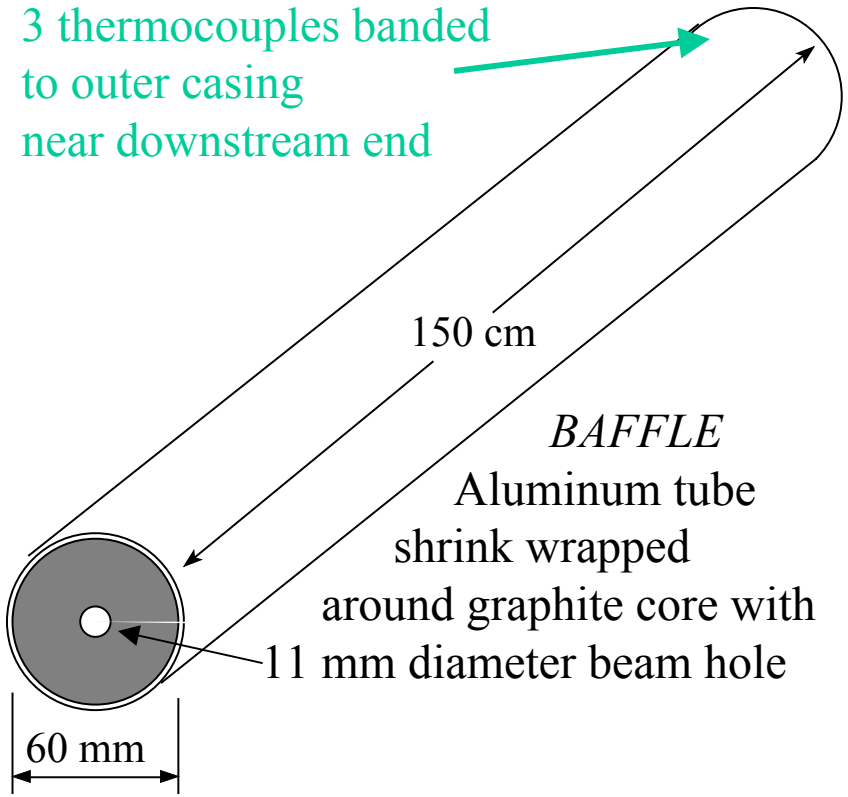


1 pulse / 2sec for 17 hours

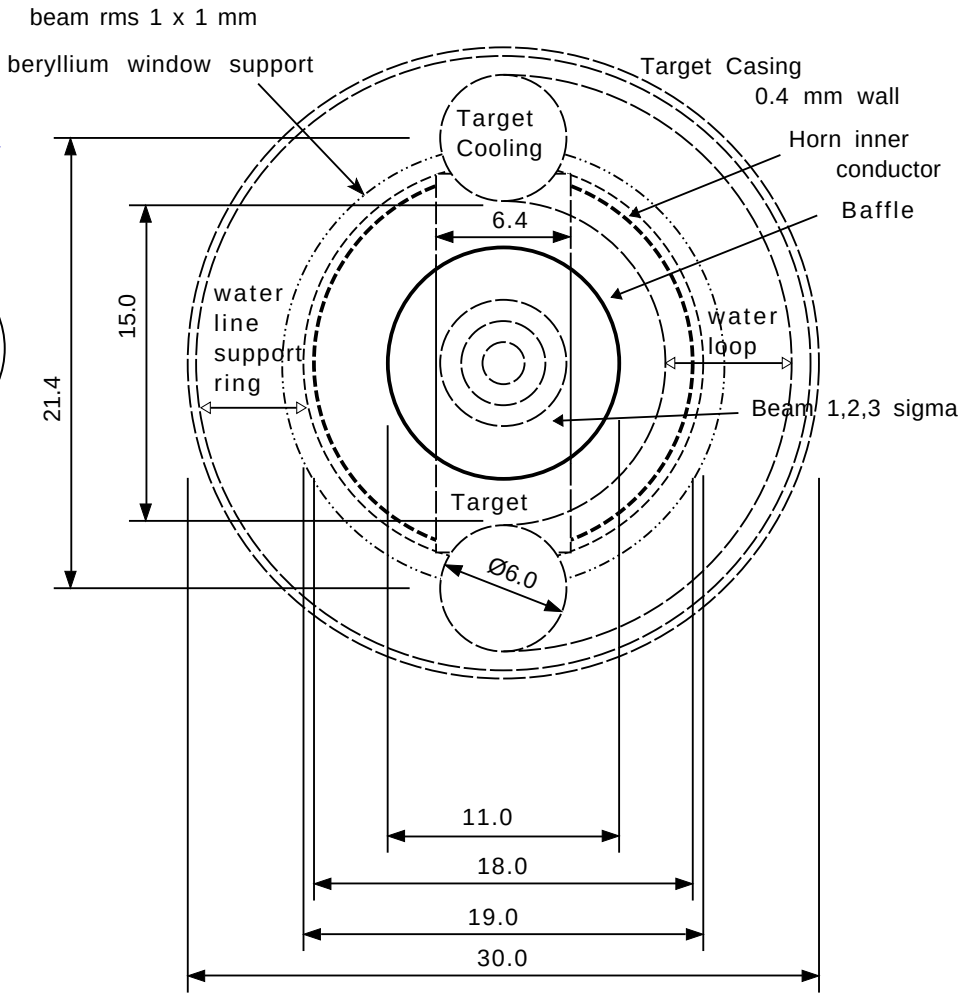
Baffle
to protect target support and horn

Protects horn neck, target cooling tubes from beam accidents

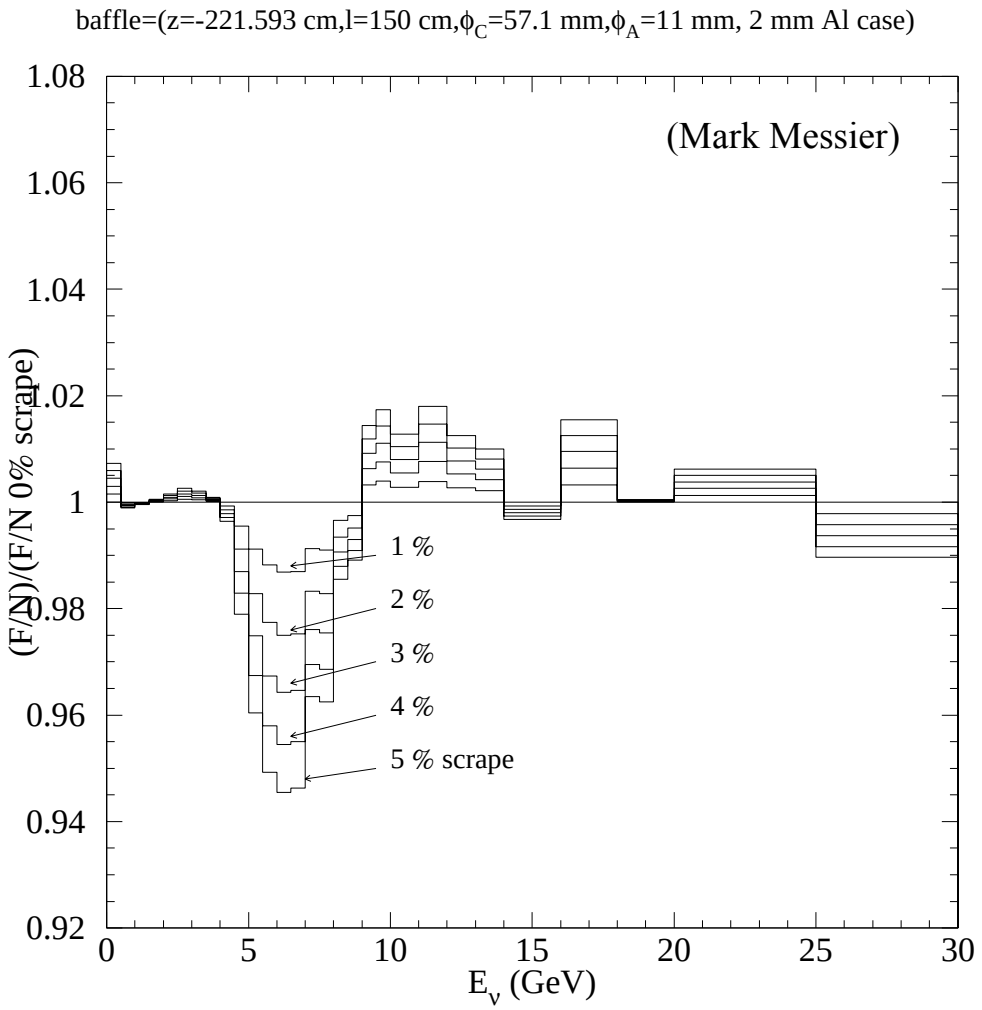
Instrumentation:
3 thermocouples banded to outer casing near downstream end



BAFFLE
Aluminum tube shrink wrapped around graphite core with 11 mm diameter beam hole



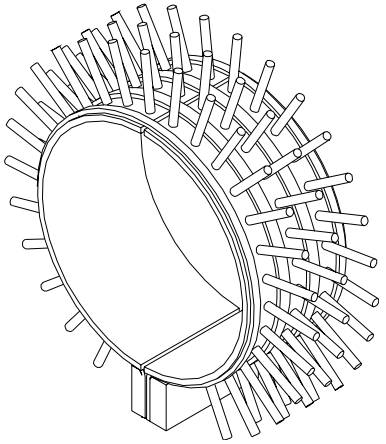
Baffle – cool !
but not too cool !



Beam scraping on baffle affects spectrum

Tune cooling so 1% scraping ~ 20 C ΔT
easy to thermocouple monitor scraping!

Done by covering 1/3 of baffle with pin radiators:
(air cool)



Calibrate by steering low intensity beam 100% into baffle

Baffle limit 100 deg C or 5% at 4e13ppp

Air Cooling System

Air system for target pile:

(i) Recirculating to lower emission of radioactivated air

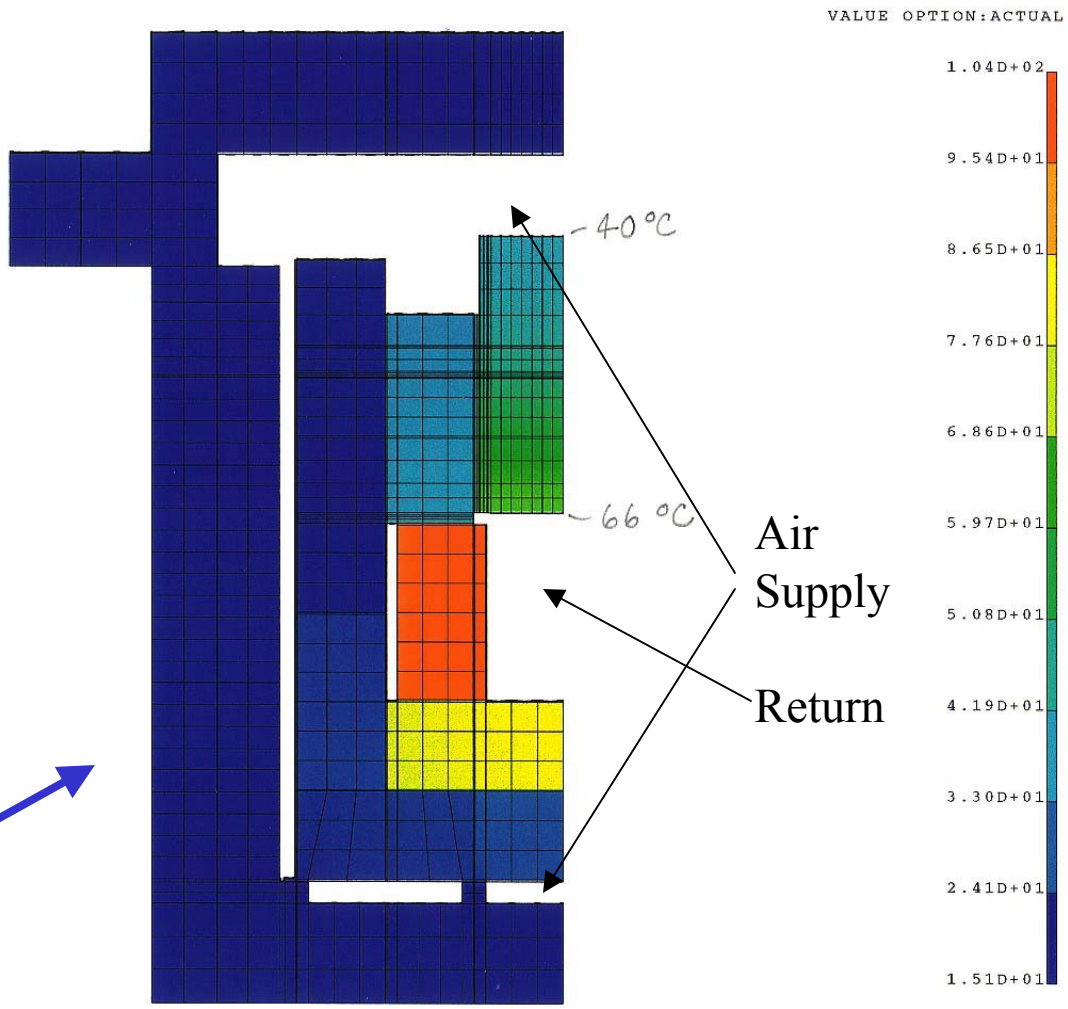
(ii) 28,000 cfm to keep components cool and limit thermally induced misalignment

(iii) Designed to remove 158 kw of the 400 kw total beam power

(iv) Trying to keep relative humidity no more than 50%

(v) High efficiency filter to capture radioactive contamination

Thermal model of module end-plate in target pile



Target pile cooling

Interlock to beam permit:

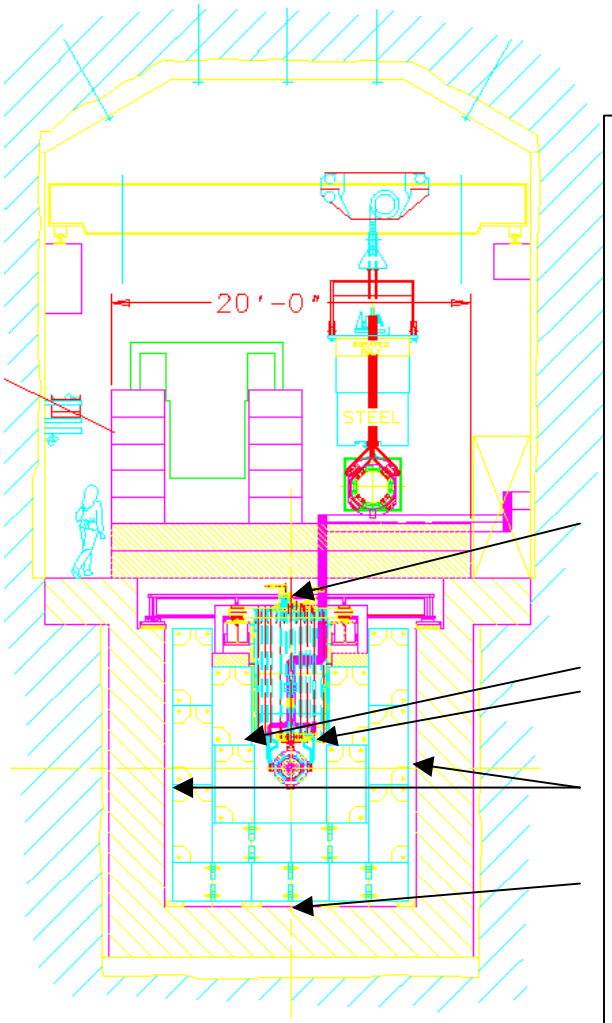
Air flow:
differential pressure

Temperature:
thermocouple at air entrance to target pile

Temperature monitoring:

Pile as shown
(not reachable to replace)

plus thermocouples on modules



Location of thermocouples

Around Horn 1 Module

2 carriage/air above module

2 on steel shielding blocks

2 on concrete walls

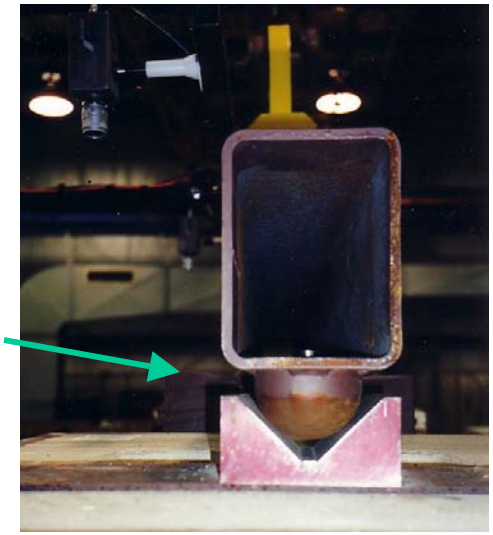
2 on concrete floor

Hot Handling Equipment: cameras, lift table controls

Some items (camera systems, lead blanket on dolly as shielding for crane operator) we will develop during tests of handling at MI-8 after components are together.

A quick test with borrowed cameras of remote handling of T-block

T-block landing guide



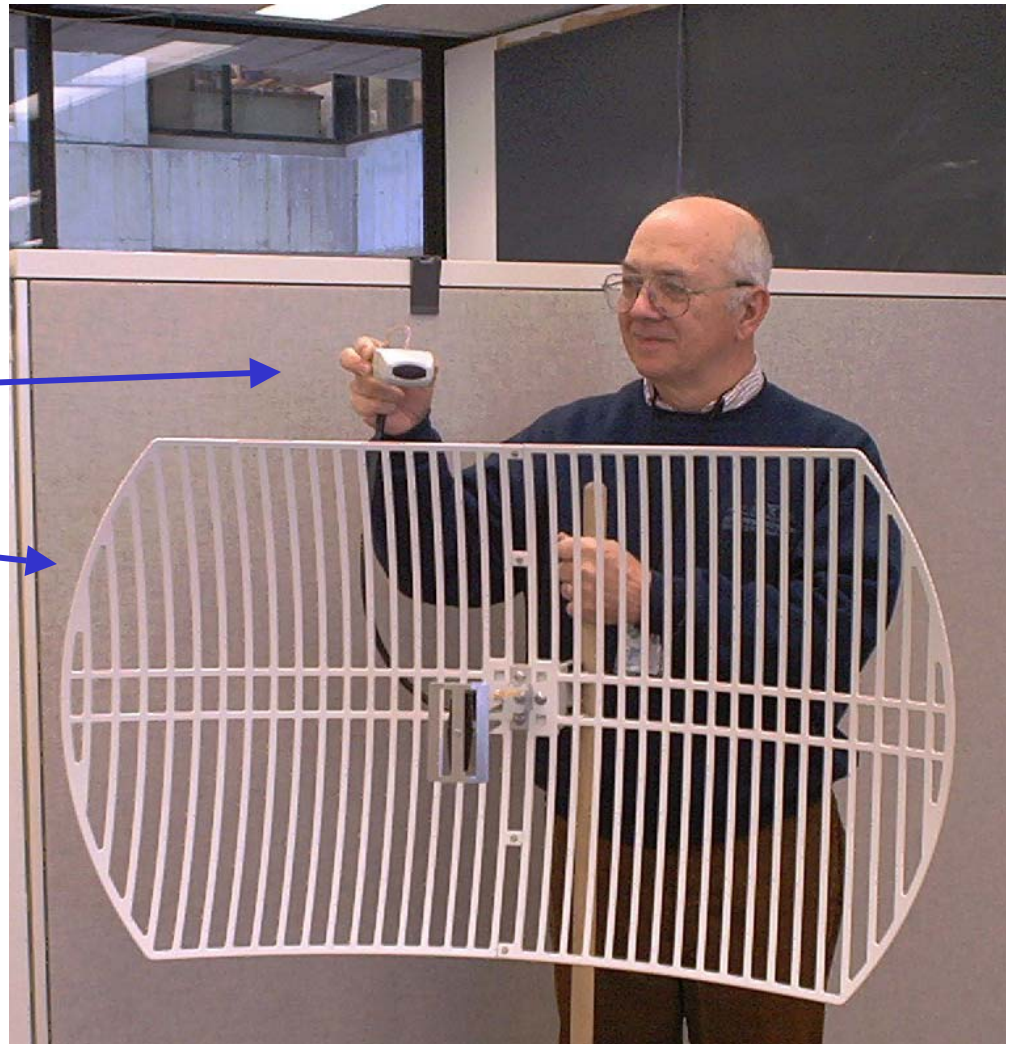
Hot handling camera system

Cheap wireless TV transmission system is being tested.

Take signal from crane to upstream end of target hall

2.4 GHz transmitter

Antenna

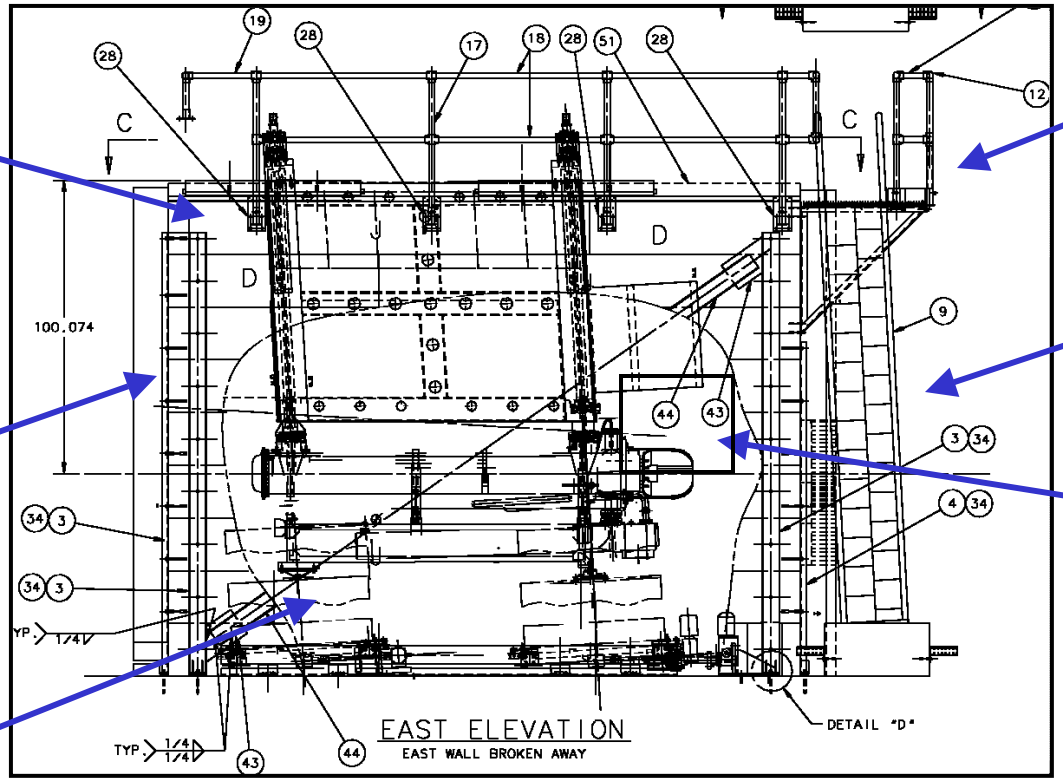


Hot Work Cell
for change-out of activated components

Concrete shield block walls

Motorized steel door

Component lifting table



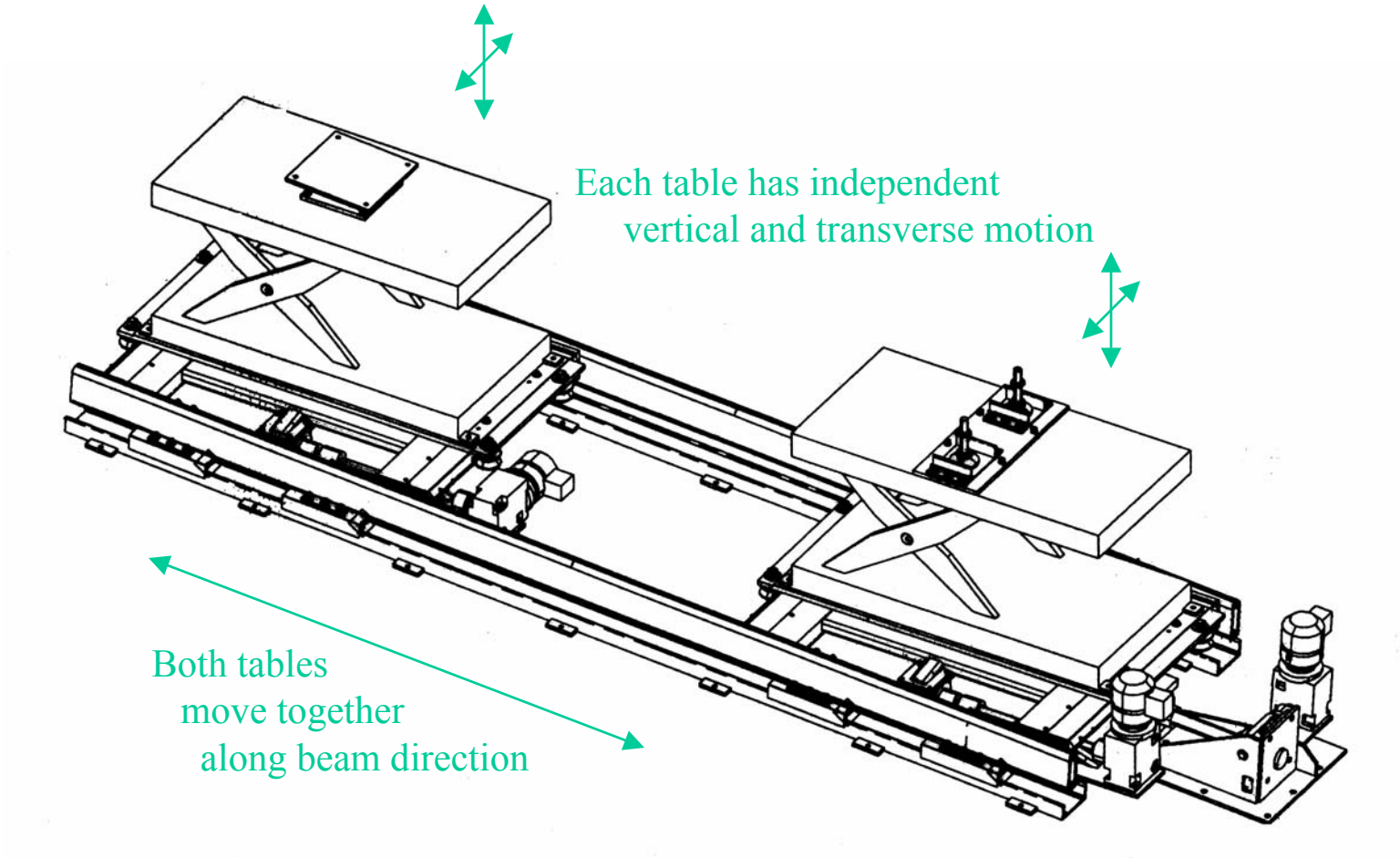
Railing, platform

Stairs

Lead glass window

Lifting Table in Hot Cell

Push horn or target up into module remotely –
5 degrees of motion



Hot cell lift table controls

Testing control system that came with lift tables.

May need modification. (e.g. table slowly sinks under load with controls off)